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Transmitted herewith for filing under 35 U.S.C. 111 and 37 C.F.R. 1.53 is the patent application of:

STEVEN R. BARD

For: **PROVIDING POWER FROM A POWER SOURCE TO A POWER SINK**

Enclosed are:

- ☒ Certificate of Mailing with Express Mail Mailing Label No. **EL594060300US**
- ☒ **Three (3)** sheets of drawings.
- ☐ A certified copy of a application.
- ☒ Declaration ☒ Signed. ☐ Unsigned.
- ☒ Power of Attorney
- ☐ Information Disclosure Statement
- ☐ Preliminary Amendment
- ☒ Other: **Recordation Form Cover Sheet; Assignment and check for $40.**

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra		Rate	Fee
Total Claims	30	- 20 =	10	x	$18.00	$180.00
Indep. Claims	4	- 3 =	1	x	$78.00	$78.00
Multiple Dependent Claims (check if applicable) ☐						$0.00
					BASIC FEE	$690.00
					TOTAL FILING FEE	$948.00

- ☒ A check in the amount of **$948.00** to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. **20-1504** as described below. A duplicate copy of this sheet is enclosed.
  - ☐ Charge the amount of as filing fee.
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  - ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: **July 19, 2000**

Signature

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INTL-0417-US
(P9417)

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: PROVIDING POWER FROM A POWER SOURCE TO A POWER SINK

INVENTOR: STEVEN R. BARD

Express Mail No.: EL594060300US

Date: July 19, 2000

PROVIDING POWER FROM A POWER SOURCE TO A POWER SINK

Background

This invention relates generally to the provision of power from a power source to a power sink and in particular embodiments to the provision of power to a battery operated device.

A wide variety of electronic devices receive power from a power source. For example, a mobile computer system such as a laptop computer may receive power from an AC adapter sometimes called a brick. Generally, each mobile computer system uses its own separate brick that provides a conversion from AC power to a DC voltage and current level that meet the requirements of a particular mobile computer system. Thus, each mobile computer system is sold with a particular AC adapter, increasing the overall cost of each mobile computer system.

It would be desirable to provide a power source that is capable of providing power to a plurality of devices. However, providing such a source risks the possibility that too many power sinks may be coupled to the power source. Overloading the source may cause the power source to fail or to provide less than the required power to one or more of the devices.

Moreover, it would be desirable to enable power sinks to couple to a power source with some degree of assurance that, despite the fact that the power source was not supplied with the system, the power source can be depended upon to supply the required power levels.

Brief Description of the Drawings

Figure 1 is a schematic depiction of one embodiment of the present invention;

Figure 2 is a schematic depiction of an embodiment of the present invention involving a mobile computer system and an AC adapter;

Figure 3 is a flow chart for software for the power source of a power source/sink pair in accordance with one embodiment of the present invention; and

Figure 4 is a flow chart for software for a sink of a power source/sink pair.

Detailed Description

A system 10 may include a power source 12 and the power sink 14 coupled by a power supplying link or connection 16b and a communication link 16a, as shown in Figure 1. In some embodiments a single cable or link may supply both power and communication channels. The source 12 may supply power over the link 16b and may exchange information with the sink 14 over the link 16a.

A power source is any device capable of providing a source of power to a power sink. A power source may be fixed in that it supplies a specific voltage level at a specific amperage level. A power source may be dynamic in that it has the capability of altering either or both of its voltage level or current capacity. A power sink is any device that consumes energy provided by a power source. A physical connection between the power source and the power sink includes a delivery mechanism for power to the sink and a communication medium between the two.

In a loosely coupled connection between the sink 14 and the source 12, the source 12 may provide a specific signal to the sink 14 for example through a reserved pin on a link 16a. The sink 14, upon detecting the signal, may determine that it may charge its internal battery from the power available from the source 12.

In a tightly coupled system, more complex communications may be possible between the source 12 and the sink 14. In such case, a communication protocol implemented by firmware or software residing on the sink 14 may make certain decisions about the amount and use of power provided by the source 12. In one embodiment, the sink 14 may determine whether the source 12 is a valid source from which the sink 14 may charge its internal battery. Thus, a tightly coupled connection between the sink 14 and source 12 may utilize a higher level of

communication over the link 16a. However, a higher level of communication may not be necessary for the sink 14 to detect that the source 12 is a device from which the sink 14 may charge its internal battery. A lower level of detection may be used for this purpose, such as the loosely coupled connection described previously.

Referring next to Figure 2, not only may a tightly or loosely coupled connection be implemented between the source 12a and the sink 14a, but moreover, a given source 12a may provide power to a plurality of sinks. Thus, in the example shown in Figure 2, the source 12a may be an AC adapter and the sink 14 may be a mobile computer system 14a. A link 16 with plugs 24 and sockets 22 provides connections between the sink 14a and the source 12a. Particularly, a plug 24a plugs into a socket 22a on the sink 14a and a plug 24b plugs into a socket 22b on the source 12a. The source 12a is coupled to a source of AC power indicated at 18.

A fan out unit 30 may receive the plug 24b in its socket 22b. However, the fan out unit 30 may also supply power through a plurality of sockets 32, 34 and 36, each capable of communicating with an additional power sink (not shown). Thus, in one example, the source 12a may power both the sink 14a and other related devices such as a cellular phone, a printer, a display device, and the like.

The source 12a may determine seriatim for each connected sink whether the source 12a has the available power resources to supply the power needs of each subsequently coupled sink. Each time a new sink is connected, the source 12a may undertake a communication protocol with the coupled sink to establish what its power needs are and to determine whether the source 12a can meet those power needs.

In one embodiment of the present invention, the source 12a may be implemented in accordance with the IEEE 1394b standard, preliminary draft P1394b, Revision 1.0, dated February 25, 2000 available from the Institute of Electrical and Electronics Engineers (IEEE), Inc., 35 E. 47th Street, New York, New York 10017. In addition, a 1394b beta socket, plug pair may be utilized, since an extra pin is available in these socket/plug pairs.

The source 12a may be a fan out physical layer or FOP. A FOP is a multi-ported physical layer that is attached to a physical layer integrated with a link layer (PIL) via a serial interface. A physical layer is a serial bus protocol layer that translates logical symbols used by the link layer into electrical signals on a serial bus medium. The physical layer is self-initializing. Physical layer arbitration guarantees that only one node at a time is sending data.

A link layer is the serial bus protocol layer that provides confirmed and unconfirmed transmission or reception of primary packets. A primary packet is any packet that is not an acknowledgement or a physical layer packet. A primary packet is an integral number of quadlets and contains a transaction code in the first quadlet. A quadlet is four bytes or thirty-two bits of data.

Thus, the sink 14a may include a 1394b physical layer integrated within a link (PIL). A PIL is a link that uses a modified beta port to attach to a FOP using the protocol defined in the 1394b standard. A beta port is a port that operates according to the specifications of the IEEE 1394b standard.

A self-ID packet is a physical layer packet that provides information about a device that transmits the self-ID packet including, for example, the device's identity, its location and its power requirements. A self-ID packet is provided, for example, from the sink 14a to the source 12a. If the source 12a includes a processor-based system such as a controller in its FOP 30, the source 12a may determine whether or not to provide the requested power.

For example, under the 1394b protocol, a primary power provider is a node that reports its power class as either one, two or three in its first self-ID packet. This type of device provides fifteen, thirty or forty-five watts to

to the power connection 16b. Thus, a serial bus connection may be provided between the PIL (sink 14a) and the FOP (source 12a) in which the FOP selectively supplies up to four coupled sinks. The FOP may provide power according to a pre-established routine. However, other non-1394b embodiments may also be used.

Referring to Figure 3, in one embodiment, the software or firmware 40 for implementing the source 12 begins by receiving the self-ID packet from a given requesting sink 14, as indicated in block 42. The source 12 may include a processor-based system such as a microcontroller, an embedded controller or a processor. At this stage, the source 12 may also have one or more connected sinks 14. As indicated in block 46, the source 12 may then receive a power class request from the sink 14. A given sink may request a power class, in accordance with one embodiment of the present invention, as indicated in block 44. This request may be in the form of a specific request for a given power class, in terms of voltage and current for example. Alternatively, the request may be simply an identifier which identifies the sink 14. The source 12 may then make a determination, based on the identifier for the sink 14, about what power class the sink needs.

If the power class requested by the sink 14 is acceptable, given the available resources of the source 12, as determined in diamond 48, the sink 14 may be given an

acknowledge signal indicating that the sink 14 may receive power from the source 12, as indicated in block 50. In one case, the power class requested from the sink 14 may be such that it enables the sink 14 to receive sufficient power to charge its battery. In other cases, the sink 14 may be acknowledged for its ongoing power needs but the source 12 may be unable to supply sufficient power to enable the sink 14 to charge its battery. If the needed power class is unavailable from the source 12, for example because of the capabilities of the source 12 or the number of power consuming sinks already coupled to the source 12, the source 12 may reject the sink as indicated in block 52.

In each case, in accordance for example with the 1394b protocol, any coupled sink 14 receives sufficient power for enumeration. Thus, the protocol indicated in Figure 3 may be accomplished with power supplied from the source 12 or from an available link 16 regardless of whether the source 12 ultimately can supply the ongoing working power needs of a given sink 14.

Referring next to Figure 4, the software 60 resident on a processor-based sink 14, begins by sending a self-ID packet as indicated in block 62 in one embodiment of the invention. The present invention is not in any way limited to the 1394b protocol. In general, a self-ID packet may be a non-1394b identifier or may be the self-ID packet described in the 1394b protocol.

The sink 14 then receives a power class request from the source 12 as indicated in block 64. The sink 14 may send its power class request as indicated in block 66. When the sink 14 receives a power decision from the source 12, as indicated in block 68, the sink 14 determines whether the decision is to reject or accept the sink 14 as determined at diamond 70. If the sink 14 is not rejected, the sink 14 continues to operate through the source 12 as indicated in block 72.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is:

1. A method comprising:

detecting the coupling of a power sink to a power source; and

sending a data signal between the source and the sink to determine whether the source can provide power to the sink.

2. The method of claim 1 including detecting the coupling of a plurality of power sinks to the power source and sending the data signal between the source and each sink to determine whether the source can provide power to each sink.

3. The method of claim 1 wherein detecting the coupling of a power sink to a power source includes receiving a self-identifier packet at the source from the sink.

4. The method of claim 1 including requesting a power class indication from the sink.

5. The method of claim 4 including receiving a power class indication from the sink.

6. The method of claim 2 including determining the available power of the source based on the power requirements of a particular sink.

7. The method of claim 2 including determining whether to supply power to a given sink based on the power requirements of any sinks already coupled to said source and the power capacity of said source.

8. The method of claim 2 including supplying sufficient power for enumeration to a sink coupled to said source.

9. The method of claim 8 wherein if the source is unable to supply power to the sink, refusing to supply power to said sink except for enumeration.

10. The method of claim 1 including sending an identifier to said source that is used by the source to determine whether the source can supply power to said sink.

11. An article comprising a medium storing instructions that enable a processor-based system to:

detect the coupling of a power sink to a power source; and

send a data signal between the source and the sink to determine whether the source can provide power to the sink.

12. The article of claim 11 further storing instructions that enable the processor-based system to detect a coupling of a plurality of power sinks to the power source and send the data signal between the source and each sink to determine whether the source can provide power to each sink.

13. The article of claim 11 further storing instructions that enable the processor-based system to receive a self-identifier packet from the sink.

14. The article of claim 11 further storing instructions that enable the processor-based system to request a power class indication from the sink.

15. The article of claim 14 further storing instructions that enable the processor-based system to receive a power class indication from the sink.

16. The article of claim 11 further storing instructions that enable the processor-based system to

determine its available power based on the power requirements of a sink.

17. The article of claim 11 further storing instructions that enable the processor-based system to determine whether to supply power to a given sink based on the power requirements of sinks already coupled to the source and the power capacity of said source.

18. The article of claim 12 further storing instructions that enable the processor-based system to supply sufficient power for enumeration to any sink coupled to said source.

19. The article of claim 18 further storing instructions that enable the processor-based system, if the source is unable to apply power to the sink, to refuse to supply power to the sink except for enumeration.

20. The article of claim 11 further storing instructions that enable the processor-based system to use an identifier from a sink to determine whether the source can supply power to the sink.

21. A system comprising:

a connection to a source of power;

a plurality of ports to couple said system to power consuming devices; and

a processor-based device which analyzes information received from power consuming devices and determines whether to supply power to said power consuming devices through said ports.

22. The system of claim 21 wherein said system includes a fan out physical layer.

23. The system of claim 21 wherein said system includes an AC adapter.

24. The system of claim 21 wherein said processor-based device determines whether to provide power to a power consuming device is connected to said system.

25. The system of claim 24 wherein said system provides power to the power consuming device for enumeration and then determines whether to provide additional power to said power consuming device.

26. A system comprising:

power consuming circuitry;

a processor-based device; and

a port connectable to receive power from a power source and to exchange a data with said power source.

27. The system of claim 26 wherein said system is a mobile computer system.

28. The system of claim 26 wherein said system includes a physical layer integrated with a link layer.

29. The system of claim 26 wherein said system includes a data plug.

30. The system of claim 26 wherein said device generates a self-ID packet that indicates the power needs of said system.

PROVIDING POWER FROM A POWER SOURCE TO A POWER SINK

Abstract of the Disclosure

A communication between a power source and a power sink determines whether the source can supply the power needs of a given sink. This determination may be based not only on the capacity of the source but also on the number of sinks already coupled to a given source. Thus, the source may be adaptable to varying power needs of coupled sinks of varying numbers.

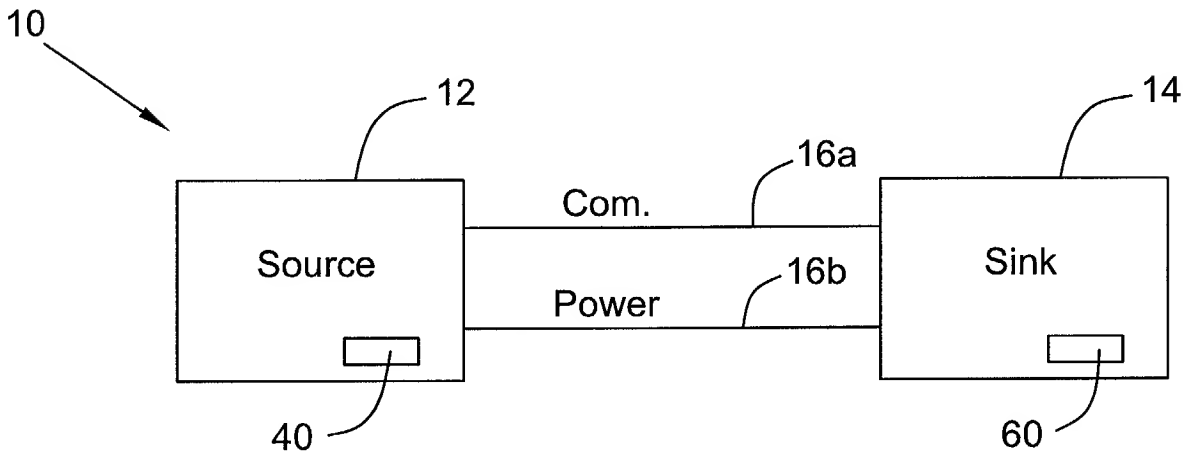

10
12
14
16a
Com.
Source
Sink
16b
Power
40
60

FIG. 1

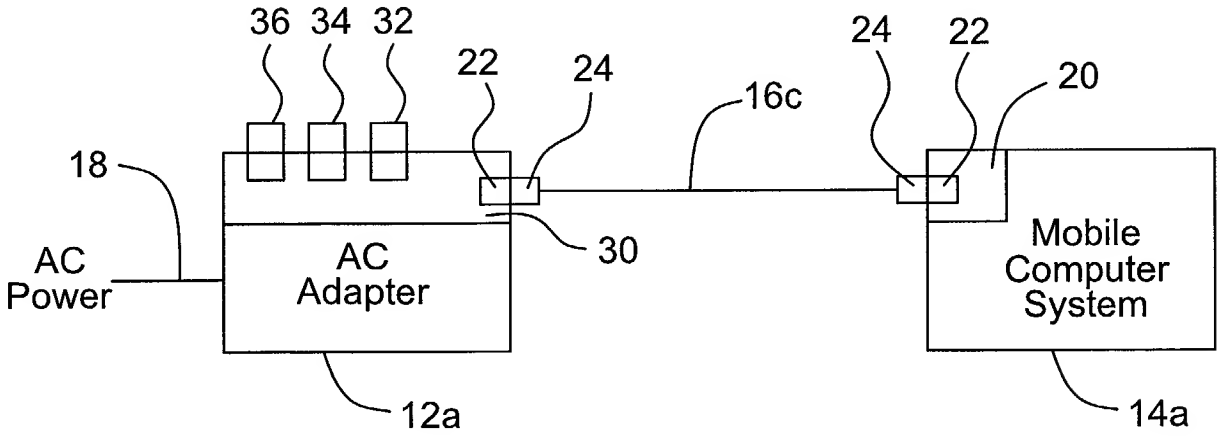

36
34
32
22
24
16c
24
22
20
18
AC
Power
AC
Adapter
30
Mobile
Computer
System
12a
14a

FIG. 2

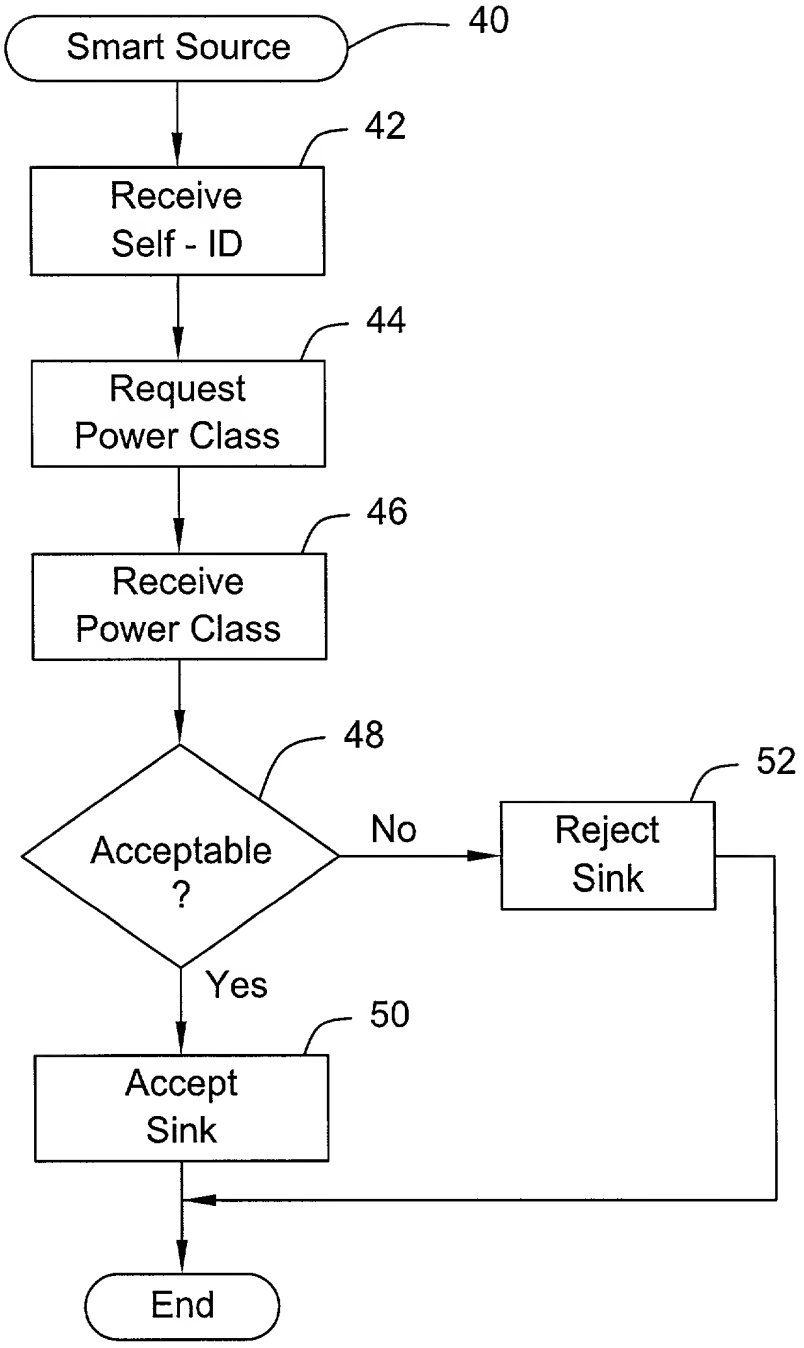

Smart Source
40
Receive Self - ID
42
Request Power Class
44
Receive Power Class
46
Acceptable ?
48
No
Reject Sink
52
Yes
Accept Sink
50
End

FIG. 3

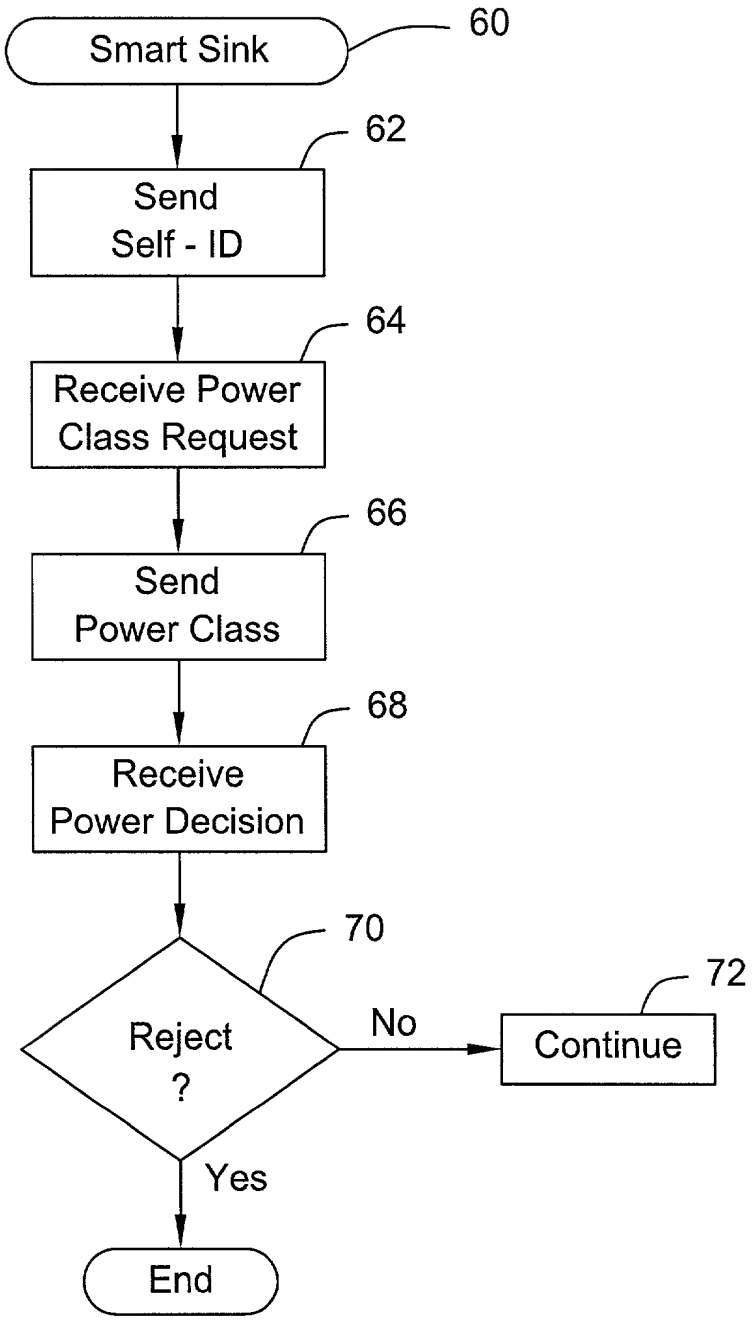

Smart Sink
60
Send
Self - ID
62
Receive Power
Class Request
64
Send
Power Class
66
Receive
Power Decision
68
Reject
?
70
No
Continue
72
Yes
End

FIG. 4

Attorney's Docket No.: INTL-0417 -US (P9042) PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

PROVIDING POWER FROM A POWER SOURCE TO A POWER SINK

the specification of which

X	is attached hereto.
	was filed on _____ as
	United States Application Number _____
	or PCT International Application Number _____
	and was amended on _____
	(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate Issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):			Priority Claimed	
Number	(Country)	(Day/Month/Year Filed)	Yes	No
Number	(Country)	(Day/Month/Year Filed)	Yes	No
Number	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of the United States provisional application(s) listed below:

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

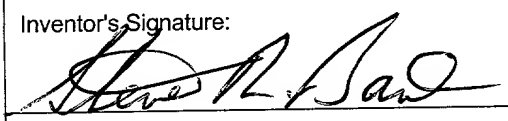
I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Number)	Filing Date	(Status-patented, pending, abandoned)
(Application Number)	Filing Date	(Status-patented, pending, abandoned)

I hereby appoint Timothy N. Trop, Reg. No. 28,994; Fred G. Pruner, Jr., Reg. No. 40,779 and Dan C. Hu, Reg. No. 40,025 my patent attorneys, of TROP, PRUNER & HU, P.C., with offices located at 8554 Katy Freeway, Ste. 100, Houston, TX 77024, telephone (713) 468-8880, and Mirho, Charles A.; Registration No. 41,199; Novakoski, Leo V.; Registration No. 37,198; Reynolds, Thomas C.; Registration No. 32,488; Seddon, Kenneth M.; Registration No. 43,105; Seeley, Mark; Registration No. 32,299; Skabrat, Steven P.; Registration No. 36,279; Skaist, Howard A.; Registration No. 36,008; Su, Gene I.; Registration No. 45,140; Wells, Calvin E.; Registration No. 43,256; Werner, Raymond J.; Registration No. 34,752; Winkle, Robert G.; Registration No. 37,474; and Young, Charles K.; Registration No. 39,435 my patent attorneys, of INTEL CORPORATION with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Timothy N. Trop, TROP, PRUNER & HU, P.C., 8554 Katy Freeway, Ste. 100, Houston, TX 77024 and direct telephone calls to Timothy N. Trop, (713) 468-8880.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor: **STEVEN R. BARD**	
Inventor's Signature: 	Date: 17 July 2000
Residence: **VANCOUVER, WASHINGTON**	Citizenship: **U.S.**
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